The Effect of Motor-Encoding Activities on Memory and Performance in a Grade One Reading Program

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ABSTRACT

This study examined the effectiveness of motor-encoding activities on memory and performance of students in a Grade One reading program.

There were two experiments in the study. Experiment 1 replicated a study by Eli Saltz and David Dixon (1982). The effect of motoric enactment (i.e., pretend play) of sentences on memory for the sentences was investigated. Forty Grade One students performed a "memory-for-sentences" technique, devised by Saltz and Dixon. Only the experimental group used motoric enactment of the sentences. Although quantitative findings revealed no significant difference between the mean scores of the experimental group versus the control group, aspects of the experimental design could have affected the results. It was suggested that Saltz and Dixon's study could be replicated again, with more attention given to variables such as population size, nature of the test sentences, subjects' previous educational experience and conditions related to the testing environment.

The second experiment was an application of Saltz and Dixon's theory that motoric imagery should facilitate memory for sentences. The intent was to apply this theory to Grade One students' ability to remember words from their reading program. An experimental gym program was developed using kinesthetic activities to reinforce the skills of the classroom reading program. The same subject group was used in Experiment 2.

It was hypothesized that the subjects who experienced the experimental gym program would show greater signs of progress in reading ability, as evidenced by their scores on Form G of the Woodcock Reading Mastery Test--Revised. The data from the WRM--R were analyzed with a 3-way split-plot analysis of variance in which group (experimental vs. control) and sex were the between-

subjects variables and test-time (pre-test vs. post-test) was the within-subjects variable.

Findings revealed the following: (a) both groups made substantial gains over time on the visual-auditory learning sub-test and the triple action of group x sex x time also was significant; (b) children in the experimental and control groups performed similarly on both the pre- and post-test of the letter identification test; (c) time was the only significant effect on subjects' performance on the word identification task; (d) work attack scores showed marked improvement in performance over time for both the experimental and control groups; (e) passage comprehension scores indicated an improvement in performance for both groups over time.

Similar to Experiment 1, it is suggested that several modifications in the experimental design could produce significant results. These factors are addressed with suggestions for further research in the area of active learning; more specifically, the effect of motor-encoding activities on memory and academic performance of children.

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CHAPTER 1: INTRODUCTION TO THE PROBLEM

This study has emerged from an interest in active learning; more specifically, the effectiveness of programs that use physical activity to enhance academic skills is the primary concern. Observations of young children indicate that they enjoy movement, both at work and at play. They appear to prosper from exposure to physical activity; likewise, they appear to suffer when it is restricted. Is it possible then, that educators can use physical activity (e.g., motor-encoding activities) effectively to enhance specific academic skills (e.g., Grade One reading skills)?

Purpose and Rationale

Empirical evidence has shown that a positive relationship can exist between kinesthetic activities and academic skills (Anthony 1971; Ayres, 1972; Friedes & Messina, 1986; Saltz, Dixon & Johnson, 1977; Thorpe & Borden, 1985). It can be hypothesized therefore, that Grade One children who are learning to read will benefit more from a program that includes physical or motor-enactment activities with visual and auditory activities.

There are two experiments in this study. The first experiment replicated a study by Eli Saltz and David Dixon (1982). In this study, Saltz and Dixon examined the effect of motoric enactment of sentences on memory for the sentences. Through the use of their own procedure known as the "memory-for-sentences" test, they noted the performance of an adult subject group and a subject group of children in the following conditions:

(1) no enactment of sentences at the acquisition phase and
no enactment of sentences at the retrieval phase;

(2) no enactment of sentences at the acquisition phase and enactment of sentences at the retrieval phase;

(3) enactment of sentences at the acquisition phase and no enactment of sentences at the retrieval phase; and

(4) enactment of sentences at the acquisition phase and enactment of sentences at the retrieval phase.

Their results showed that both adults and children showed better memory of the sentences when motoric imagery (enactment) was used. It was also found that enactment at the acquisition phase was more effective in facilitating memory for the sentences.

As stated earlier, Experiment 1 was a replication of the Saltz and Dixon study (1982) with two exceptions. The manner in which enactment of the sentences affected memory for the sentences was investigated with a group of children (Grade One students) rather than adults. The other difference involved the experimental conditions. Whereas Saltz and Dixon used four subject conditions, Experiment 1 focused on only two of these conditions:

(1) no enactment at the acquisition phase and no enactment at the retrieval phase; and

(2) enactment at the acquisition phase and enactment at the retrieval phase.

Using the same "memory-for-sentences" procedure as Saltz and Dixon, Experiment 1 considered their prediction that motoric imagery facilitates memory for sentences in children.

The second experiment in this study was intended to be an application of Saltz and Dixon's findings. It investigated the hypothesis that Grade One children who are learning to read, will benefit from a physical education program that deliberately reinforces skills that are presented to the children in

their reading program.

Statement of Hypotheses

The first hypothesis is that the subjects' memory for the sentences will improve when motor enactment of the sentences' meaning is included with visual and auditory methods of learning.

The second hypothesis is that the subjects who experienced the experimental gym program that used kinesthetic activities to reinforce the skills of the classroom reading program will show greater signs of progress in reading ability, as evidenced by their scores on the Woodcock Reading Mastery Test--Form G.

Importance of the Study

The results of this study have value for practitioners, particularly those that work with children who have difficulty with reading skills. Useful information is provided that may help in the development of a primary level physical education program that can complement and reinforce the academic skills that are taught in the classroom.

The relationship between student learning and attention to task is addressed. Since the very nature of active motor involvement is more deliberate than visual or auditory processing, information processing is probably more thorough. This leads to implications regarding the use of classroom experiences that encourage students to use learning modalities such as motor enactment that require more attention.

Motor-encoding activity may contribute to the meaning of natural language, as well as improve memory of language elements. Motor enactment of a word or sentence encourages the subject to form a motoric image that becomes a

part of the word or sentence's meaning. This process, along with the stimulation of attention, should facilitate memory of the word or sentence (Saltz & Dixon, 1982). It can be seen then, that individuals studying language acquisition and teachers of second languages may find aspects of this study relevant to their respective fields.

Teachers specializing in reading instruction and second-language acquisition can apply the use of motor enactment effectively in their teaching practice. Physical enactment of words or phrases can reinforce the students' understanding of word meanings (Saltz & Donnenwerth-Nolan, 1981). Similar activities in a second-language classroom can serve as an effective means of introducing new words and their meanings. These factors indicate implications of this study and its results.

Music instructors have already discovered the use of body actions to assist students in learning words or songs (Cratty, 1985). There are aspects of this study that are relevant to those who are involved in music instruction.

Motor activities are also useful in classroom activities that require the use of memory. Physical actions associated with a series of things to be remembered are often helpful with students who have difficulty remembering a series of instructions (Cratty, 1985; Levin, 1976; Saltz & Dixon, 1982). This application of the study's focus is particularly appropriate for teaching practices with learning-disabled students and young children.

It can be seen that significant value exists in the results of this study, particularly for teaching practitioners who work directly with students and their various styles of learning.

Definition of Terms

Active learning for the purposes of this study is an educational approach in

which students are encouraged to acquire knowledge by using all four learning modalities: visual, auditory, tactile and kinesthetic.

Kinesthetic activities are activities that involve body motion and muscular movement.

Motor enactment refers to physical representation of a thought with body actions; similar to pantomime.

Motor-encoding activities are activities that involve interpretation of a thought through muscular movement.

Outline of Remainder of the Document

The following pages include a review of literature that is related to active learning and the use of physical activity (e.g., motor-encoding activities) to enhance academic skills, particularly, reading skills.

The third chapter discusses the research designs that were used in both Experiments 1 and 2 and the rationale for choosing each. Subject selection, procedures and the data collection are outlined, as well. Finally, the method used in the analysis of the results is discussed.

The fourth and fifth chapters include presentation and discussion of the results of each experiment. The limitations of each experimental design are discussed with recommendations for possible changes. Finally, conclusions are drawn with suggestions for further research in the area of active learning and its effect on academic skills.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

Historical Overview

Active learning as a teaching approach originated in the late 1700s and early 1800s. French and German educators recognized the value of free movement with young children. It was their belief that children need movement; thus, structured and unstructured play experiences were introduced in some school programs (Cratty, 1972). The Froebelian Kindergarten, established during this era, based its approach on the theory that children can use motor activity in which they are interested, to learn and acquire information, understanding and skill.

The use of sensory-motor experiences as an educational strategy was supported by Jean-Marc-Gaspard Itard's historic study in the early 1800s, The Wild Boy of Aveyron. Itard's historic work with Victor, the "wild boy," revealed that sensory education and active approaches can enhance learning. For example, he developed tactual sensitivity to heat by applying heat to Victor's skin, using extremes of temperature (Itard, 1932).

Edward Seguin, a student of Itard, was also considered to be a pioneer in the study of sensory education. He made use of tactual-kinesthetic exercises to facilitate learning. Itard believed that the exercises would lead to an enhancement of the child's active and purposeful participation in the task (Seguin, 1907).

In the early 1900s, Maria Montessori's work with deprived children made use of movement experiences. Her activities involved manual manipulation of materials and exposure to concrete materials that were representative of specific objects. Education for a New World, written by Montessori in 1946, describes her kinesthetic method of teaching reading and writing.

Active learning research studies appeared again in the years following World War II. Many were instigated by an interest in human personality and a possible motor component of personality. For example, Strauss and Lehtinen (1947), two specialists in personality research, identified what they called brain-injured children (cited in Cratty, 1973). They described these children as perceptually deficient, often hyperactive and in many cases, having motor coordination problems. This condition became known as the Strauss Syndrome. The work of these clinicians led to the development of remedial methods for use with brain-injured children, with the intention of improving academic competence.

From the 1950's until the present, some researchers and educators have focused attention on the movement part of the Strauss Syndrome and the use of Strauss and Lehtinen's remedial methods. Their support has been directed towards the development of programs that have stressed the use of motor activities to enhance the child's total education. This interest in active learning has produced four main schools of thought.

The first approach is a perceptual-motor method in which exposure to movement activity is used to enhance human abilities. Writers such as Newell Kephart (1960) have studied the manner in which infants investigate their environment in a direct manner. From these observations, it has been suggested that motor activity is essential to the development of perceptual ability. Since perceptual learning is believed to be the cornerstone of all learning, then motor activity is a tool to use in developing higher levels of intellectual functioning. Programs from this approach make extensive use of motor activities that aim at increasing the child's awareness of the world and as a result, lead to performance that is successful.

Another approach that has caused controversy is that of the Doman-

Delacato (1963) group in Philadelphia. They state that children pass through distinct stages of development that are similar to the evolution of the human being from the earliest stages as a water animal. The wriggling of a fish and the reflex squirms of an infant are seen as being similar. Early attempts at locomotion and the performance of manipulative acts in the developing child are compared to similar acts of amphibians, mammals and primates.

The Doman-Delacato approach (cited in Cratty, 1973) advocates a program that includes basic movement activities that are similar to the actions of animals. The child is taken through a sequence of movements that cause an adjustment of the child's neurological organization. Advocates of this approach believe that it may enhance abilities that reflect intellectual and perceptual functioning. The success rate with this approach has not been consistent and as a result, it has become a topic of controversy. In recent years, the Doman-Delacato approach has been explored further in the work of Dr. Paul Dennison (cited in Savage, 1985). It has become known as educational kinesiology.

A third approach is the dynamic approach. Studies done by James Oliver in England (cited in Cratty, 1973) and Ernest Kiphard in Germany (cited in Cratty, 1973) have shown that physical activity that provides pleasure and success can improve a child's self-concept and result in increased effort when performing tasks that reflect intellectual and motor functioning. Strengthening the ego through successful engagement in movement tasks stabilizes the personality, and thus improves the child's ability to cope with classroom tasks.

The fourth approach employs movement activities that are specifically based on cognitive skills. Intellectual functions and academic operations can be enhanced through the use of movement activities that have been paired precisely with the intellectual skills to be changed. Jean Le Boulch (1967), Louis Picq and Pierre Vayer (1968), James Humphrey (1975), Muska Mosston

(1966) and Bryant Cratty (1971) are notable investigators and supporters of this approach.

Recent years have produced several investigations that focus on the use of kinesthetics to enhance cognitive skills. Play and drama activities have been used to facilitate vocabulary development and components of meaning associated with the material to be learned (Saltz, Dixon & Johnson, 1977).

In a report written by Ogletree and Lillie (1976), reference is made to the motor development approach. It is described as an approach that believes that children are predominantly movement-oriented and that they will achieve better results when academic learning occurs through the use of physical activity. The movement approach encourages active involvement in various motor experiences that reinforce academic skills and concepts. Several studies report similar views (Cobb, Chissom & Davis, 1975; Humphrey, 1975).

The enhancement of language learning through the use of physical activities has been a topic of past investigations. The results of several studies suggest that images or traces from a motoric response may form much of the meaning of many natural language concepts (Bruner, 1964; Guthrie, 1952; Osgood, 1952; Piaget, 1962; Saltz, 1971). Young children appear to use motor activity to associate meaning more than adults do. Bruner and Piaget's work are most direct in suggesting that sensory motor factors may be more important for conceptual representations of young children.

The nature of the relationship between the perceptual-motor domain and academic skills is relevant to this discussion. Several research reports have proposed a positive relationship between the development of perceptual-motor skills and the enhancement of academic skills. Coordination exercises of the entire body have been used successfully to improve academic competence (Ayres, 1972). Other reports indicate that an improvement in perceptual-motor

skills can have a positive effect on progress in academic skills (Anthony, 1971; Falik, 1969; Harris & Jones, 1982). A strong background in sensory experiences such as physical movement associated with material to be learned has been shown to have a positive carry over effect to later years (Grant, 1985).

Another focus of past research has been the use of kinesthetics in reading instruction. Children demonstrate better memory for words when motor-oriented material is used to enhance and extend the experience of simply observing the word shapes visually (Cratty 1972; Humphrey, 1976; Humphrey & Moore, 1965; Zorotovich, 1985). The nature and frequency of instruction has been shown to have an effect on the student's knowledge and use of words; therefore, learning activities that are rich and extend beyond the classroom are most effective (McKeown, Beck, Omanson & Pople, 1985).

Exploration of a multisensory approach to reading instruction occurred as early as 1937. The respective works of Samuel Orton (1937) and Grace Fernald (1943) have provided evidence that multisensory instruction allows maximum sensory input to the brain. Recognition of the distinct features of a particular learning task is improved when all senses are actively involved. Use of a kinesthetic or total body movement approach with students who have reading problems has also been shown to be more successful than traditional classroom methods (Van Osdol, Johnson and Geiger, 1974). Later reports support this view (Gillingham & Stillman, 1965; Grant, 1985; Thorpe & Borden, 1985).

It can be seen that there is ample material available to support the theory that physical or kinesthetic activities can enhance academic skills and more specifically, reading skills. The investigation of the effect of motor activities on memory will now be discussed.

Significant improvements in memory have been observed in studies that

used motor manipulation of toys (Levin, 1976) and mime activities (Paris & Lindauer, 1976; Saltz & Dixon, 1982) to enhance memory. There is, however, controversy as to the direct cause of the memory improvement. Critics argue that the use of the physical component increases the attention given to the task. An increase in attention to task should result in increased learning (Bloom, 1976; Carroll, 1963; Hyman & Cohen, 1979). The controversy rests in the true cause of improved memory scores. One view argues that motor activities affect memory indirectly and that increased attention to task is the true facilitator of memory.

Active rehearsal has been shown to have a positive effect on the short-term retention of verbal information (Ellis, 1970). The use of motor activities to teach learning-disabled children has also shown positive results. Increased rehearsal caused by physical activity results in enhancement of learning through facilitation of the rehearsal processes (Bauer, 1977).

Few studies have provided evidence that deal specifically with the effect of motor-encoding activities on short memory in first-grade readers. Those that are closely related indicate that motoric representation of words may lead to the formation of an internalized imaginary representation, particularly in children who are in an operational stage of learning (Friedes & Messina, 1986; Grant, 1985; Levin 1976). This increased level of information processing should result in memory improvement and increased learning.

Summary

This chapter has provided an overview of the literature that is related to this study. It can be seen that past research indicates a positive relationship between the use of motor-encoding activities and the enhancement of cognitive development in children.

Limitations

There are limitations in this study that should be identified at this time. First, the size of the subject population is small and could affect the ability of the statistical model to identify any clear realtionships.

Although there is ample research available related to this study's topic, it tends to be gender-biased with few females included in the studies. It would seem appropriate to question whether the research findings apply to females, as well as males.

Another limitation to consider is the past educational experience of the subjects. Some of the students come from a Montessori Kindergarten programme while others come from a Senior Kindergarten programme, both within the same private school. A few of the students are new to the school and have experienced a half-day Kindergarten programme at their former schools. The nature of their previous experience with reading activities and active learning activities could act as a limitation.

Finally, the study focuses on only one school. This is a limitation since the results are not generalizable.

CHAPTER THREE: METHODOLOGY AND PROCEDURES

There are two experiments in this study; therefore it is appropriate to discuss each one individually. The details of the experimental design in Experiment 1 are discussed first, followed by a description of the experimental design that was used in Experiment 2.

Experiment 1

Method

The first experiment replicated a "memory-for-sentences" technique that was devised by Eli Saltz and David Dixon (1982). In their study, Saltz and Dixon investigated the effect of motoric imagery on memory for both isolated words and for sentences. They were interested in the performance of adult subjects in comparison to a subject group of children. They also observed the effect of motor-enactment activity at the acquisition stage of learning the words or sentences as opposed to motor enactment at the retrieval stage of remembering the words or sentences.

Experiment 1 of this study focused on the performance of children only. It was more practical for the purposes of the investigation to include only two conditions: the presence of motor enactment versus the absence of motor enactment. It can be seen then that the study replicates one component of the Saltz and Dixon study.

Subjects

Subjects in the study were students from two Grade One classrooms at a large independent day school. There were 40 students in total, including 20

boys and 20 girls. Their ages ranged between 5 years 7 months and 6 years 11 months. The children were native English-speakers with the exception of three students who spoke Korean as their first language with English as their second language. Two were subjects in the control group and one was a subject in the experimental group. In another child's home, both English and Italian were spoken. This student was in the control group of subjects.

The children were from homes with socioeconomic backgrounds that ranged from middle class to the very wealthy. Since the school is independent and privately funded, the parents pay considerable amounts for tuition. The majority of the children lived in an urban setting.

At the beginning of the school year, arrangements were made to speak to parents of the Grade One students at a parent night. The study was discussed and a letter of consent was distributed for parents to sign (see Appendix A). Only one parent declined consent; therefore, her child was placed in the control group that experienced the regular gym and reading programs.

A method of random assignment was used to place students in the control or experimental group. This helped to provide control of possible differences in teaching styles of the classroom teachers. Each class consisted of twenty students; therefore, ten students from each class were placed in each group. It seemed desirable to control for known sex differences in beginning readers as well as sex differences in behaviour during gym classes (Maccoby & Jacklin, 1980); therefore, each group had equal numbers of males and females.

A pilot test (see Appendix C) was performed in the Spring term that preceded the Fall term during which the experiment was completed. During the pilot test, 24 Grade One students were given a series of 4 sentences each, chosen at random from Saltz and Dixon's list of sentences. Twelve of the students acted out the sentences, similar to the procedure used with the experimental group in

the study. The remaining twelve students repeated the sentences twice, similar to the intended action of the control group in the study. The purpose of the pilot test was to ensure that the time needed to say the sentence twice was indeed the same as the time needed to say the sentence once in addition to acting the sentence out one time.

Procedure

As this study aimed to replicate Saltz and Dixon's (1982) results, the memory-for-sentences test they constructed was used. Each subject learned twelve simple active sentences as follows:

(a) The WORKMAN was digging a HOLE in the ground.

(b) The DOCTOR fell asleep in the CHAIR.

(c) The MOTHER cut the PAPER into small pieces.

(d) The SQUIRREL was eating green ACORNS.

(e) The SOLDIERS marched into BATTLE.

(f) The MAN was chopping WOOD in the barn.

(g) The HORSE jumped over the FENCE.

(h) The TEACHER pointed a FINGER at the blackboard.

(i) The FIREMAN ran toward the burning BUILDING.

(j) The BOY threw a STONE into the water.

(k) The BABY waved goodbye at the DOG.

(l) The AIRPLANE was flying high up over the CLOUDS.

The verb has been underlined in each sentence and the two critical words for recall are capitalized.

Subjects were informed that they were playing a memory game in which they were trying to remember the sentences that they heard. They were tested individually. A trial practice was included to ensure that the subjects

understood the appropriate procedure.

The experimental group was directed to repeat the sentence once, exactly as read by the instructor. Then, they were asked to "act out" the meaning of the sentence immediately. For example, after hearing the instructor say, " The cow jumped over the moon," the subject repeated the sentence and then, proceeded to perform the actions of jumping over an imaginary moon. This was done once for each sentence.

The control group heard the sentence and then, repeated it twice. This served as a control for the additional rehearsal that was a natural aspect of the motor-encoding condition. In both groups, the rate of presentation was approximately twelve seconds per sentence. After the last sentence in a set was presented, the subject counted by integers from 1 to 90 and then, the retention test for memory took place. The act of counting to 90 was included to act as interference for memory. The test of memory for each subject consisted of verbal presentation of the main verb of each sentence, and these were given in random order. Then, the subject was asked to recall the entire sentence. The score for each sentence ranged from 0-2 points with one point allowed for the subject and object of each sentence; hence, the total score over the twelve sentences ranged from 0-24 points. A *t* test applied to the memory scores was used to determine if there was a significant difference between the mean score of the experimental group in comparison with the mean score of the control group.

Experiment 2

Method

The second experiment was designed to investigate the effect that an active

learning approach had on Grade One students' performance in reading skills. The work of Saltz and Dixon (1982) has shown that adults and children score better on memory tests when they physically act out the information to be remembered. The intent in Experiment 2 was to explore the possibility of enhancing students' performance in reading in the classroom through the use of gym activities that deliberately reinforce these skills.

The second experiment consisted of three phases: a pre-test phase, an eight-week gym and reading program and a post-test session.

Subjects

The subjects were the same group of students that participated in Experiment 1. All subjects, with the exception of the student without parental consent, participated in the pre- and post-test sessions.

Procedure

During the pre-test and post-test phases, all subjects completed the Woodcock Reading Mastery Tests--Revised, Form G (WRM--R) (Woodcock, 1987). This test was chosen for the study because it tests three different aspects of reading: word identification, phonic skills and reading comprehension. Moreover, the relatively recent norming of the test was seen as an advantage. In the Tenth Mental Measurements Yearbook, Cooter (1989) and Jaeger (1989) describe this revised test as carefully normed and reliable, but they cautioned that more research data on the reliability of tests should be provided if the test is to be used for making a detailed diagnosis of an individual's reading problems. As individual diagnosis is not a purpose of this study, the test was adopted for use.

The test was administered to all subjects by the principal investigator during

the pre-test phase. The subjects were already familiar with this individual as she was their regular gym teacher. Another individual, unfamiliar with the subjects and the experiental design was asked to administer the post-test phase of the test to create a "blind" test situation. He was not told the subjects' placements according to control and experimental groups. This acted as a control for the possibility of tester bias. A period of time prior to testing was allowed so that the "blind" tester could gain familiarity with the students and thus, create a more comfortable testing environment for tester and subject alike.

The results from the pre-test and post-test were compared to determine any differences between the control and experimental groups. Consideration was also given to attendance scores for the two groups since a difference in attendance scores could give one group an advantage.

The experimental period consisted of an eight-week program that focused on the reading and gym classes. During this time, both the experimental and control groups experienced the same reading program but the gym program varied. The experimental group's gym activities were deliberately planned to complement the reading program through the inclusion of physical activities that reinforced the activities of their reading program. The control group experienced the regular gym program.

The experimental gym program consisted of a variety of games that were adapted so that they reinforced aspects of the reading program. Some of the games were already familiar to the children but slight changes were made to incorporate the reading skills.

An example of this is the game called Circle Tag. In this game, participants sat in a circle formation. The instructor gave each student a number name as she walked around the circle such that the first student was "1," the second student was "2" and the third student was "3" and then, the fourth student was

given the number name "1," the fifth student was "2" and the sixth student was "3". This designation of number names continued until all of the students had a name. The instructor then called out a number and all of the students with that number name ran around the outside of the circle clockwise, in a circular tag game. The object was to run fast enough to tag the people running in front of a player but also, avoid being touched by any players who were chasing from behind. A player who was tagged immediately had to return to his place at the circle. Usually, players were tagged quickly, leaving one player as the successful runner.

The adaptation of this game for the experimental gym program was to assign word names to the participants, using three of the sight words from the reading program. The instructor could call out the word names (e.g., cat, dog, rat) or use an enlarged styrofoam die that had the word names attached to it. The children were encouraged to shout out the word on the die once they recognized it, thus utilizing the learning modes of speaking and listening, too. Introduction of verbs in the reading program allowed the gym instructor to adapt the game such that children would be required to move around the circle in whatever method was indicated by the particular verb (e.g., run, hop, skip, walk).

During this phase of the study, the classroom and gym teachers worked closely on a daily basis to ensure that the planned gym activities related directly to the topics of the reading program. Daily visits and involvement by the gym teacher during reading classes made it possible to design gym activities that accurately reflected appropriate reading skills. A daily log was kept to ensure accurate description of the gym activities and program at the end of the study.

CHAPTER FOUR: RESULTS

The results from this study will be presented in two sections. First, there will be a discussion of the results from data collected in Experiment 1, the replication of Saltz and Dixon's "memory-for-sentences" technique. Then, the discussion will focus on the data from Experiment 2.

Experiment 1

As described earlier, Saltz and Dixon's test for recall involved the subject, verb and object of each sentence. Subjects were presented with the main verb of each sentence, given verbally in random order. Then, they were asked to recall the entire sentence. A point was given for the verbatim recall of the sentence subject and the sentence object, so that the score for a sentence ranged from 0-2 points and the maximum score over the 12 sentences ranged from 0-24 points.

Since observations were described numerically, the data collected were quantitative. As shown in Table1, calculation of the means and standard deviations of the test scores for the two groups was completed. A *t* test (Kirk, 1968) was used to determine any significant difference between the mean score of the experimental group as compared with the mean score of the control group. The *t* test indicated no significant difference, $t(35) = 1.42$, $p = .16$.

Experiment 2

The WRM--R data were analyzed with a 3-way split-plot analysis of variance (Kirk, 1968) in which group (i.e., experimental vs. control) and sex were the between-subjects variables and test-time (i.e., pre-test vs. post-test) was the within-subjects variable. The *F* tables for each analysis are included in

Table 1. Experiment 1: Mean Number of Critical Words Recalled.

Group	n	M	SD
Enactment	19	14.21	4.6
No Enactment	20	12.22	3.8

n = sample size; M = mean score; SD = standard deviation.

Appendix D.

Five tests from the WRM--R were used: visual-auditory learning, letter identification, word identification, word attack and passage comprehension. Data from each test are presented individually.

(1) Visual-Auditory Learning

As can be seen in Table 2, children in both the experimental and control groups made substantial gains overtime on the visual-auditory learning sub-test, $F(1,34) = 66.14$, $p < .001$. However, the triple interaction of group x sex x time also was significant, $F(1,34) = 4.36$, $p < .05$ (cf. Table 2). As Table 2 illustrates, the females in the experimental group did not make gains to the same degree seen as females in the control group and males in both groups.

(2) Letter Identification

At the time of the pre-test session, children in the experimental and control groups performed similarily on the letter identification task. The gains made over time were comparable as is shown in Table 3, $F(1,34) = 10.15$, $p < .01$.

(3) Word Identification

The only significant effect on the analysis of the subject's performance on the word identification task was time, $F(1,34) = 10.41$, $p < .01$. Table 4 shows that children in both groups made substantial gains on this test over time, but there was no differential effect due to group, $F(1,34) < 1$, $p > .05$.

(4) Word Attack

Table 5 illustrates that both the experimental and control groups experienced marked improvement over time, $F(1,34) = 13.20$, $p = .001$, with males in the

Table 2. Experiment 2: Means and Standard Deviations for the Visual-Auditory Learning Subtest.

	Experimental		Control	
	Male	Female	Male	Female
Pre-Test	101.6 (14.2)	94.9 (16.85)	86.6 (15.6)	92.2 (21.37)
Post-Test	125.7 (9.88)	104.5 (24.28)	104.8 (17.86)	115.2 (20.2)

Table 3. Experiment 2: Means and Standard Deviations for the Letter Identification Subtest.

	Experimental		Control	
	Male	Female	Male	Female
Pre-Test	101.7 (7.5)	102.2 (13.9)	95.25 (8.43)	107 (8.66)
Post-Test	105.4 (9.77)	106.7 (13.9)	98.375 (9.102)	106.7 (8.32)

Table 4. Experiment 2: Mean Scores and Standard Deviations for the Word Identification Subtest.

	Experimental		Control	
	Male	Female	Male	Female
Pre-Test	108.3 (16.479)	109 (19.01)	102.375 (14.73)	104 (21.88)
Post-Test	116.4 (17.627)	110.8 (17.84)	109.125 (14.496)	113 (12.23)

Table 5. Experiment 2: Mean Scores and Standard Deviations for the Word Attack Subtest.

	Experimental		Control	
	Male	Female	Male	Female
Pre-Test	89 (18.379)	91.6 (26.18)	88.25 (17.169)	89.4 (21.834)
Post-Test	103.5 (16.575)	98.6 (17.589)	99.0 (9.103)	93.3 (23.152)

experimental group showing the greatest gain and females in the control group showing the least improvement.

(5) Passage Comprehension

Results from the final sub-test used in Experiment 2 are shown in Table 6. Time improved performance in both groups, $F(1,34) = 49.34$, $p < .001$, but the data indicate no significant difference between the experimental and control groups, $F(1,34) < 1$, p = N.S.

Table 6. Experiment 2: Mean Scores and Standard Deviations for the Passage Comprehension Subtest.

	Experimental		Control	
	Male	Female	Male	Female
Pre-Test	100.1 (14.587)	102.1 (15.652)	98.375 (8.210)	99.4 (12.817)
Post-Test	108.1 (10.354)	108.9 (13.715)	108 (9.071)	108.6 (8.222)

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

The purpose of this study was to determine the relationship between physical activity and specific academic skills. Much of the available literature suggested that learning can be enhanced when a multisensory or kinesthetic approach is used, particularly with children. It seemed appropriate to examine the nature of this relationship further to determine recommendations, if any, for improving present teaching methods that are used in primary classrooms; specifically, Grade One reading programs.

The discussion will focus on the results of Experiment 1 first and then, the results of Experiment 2.

Experiment 1

Experiment 1 attempted to replicate an experimental procedure designed by Saltz and Dixon (1982), in which motoric imagery was used to improve memory for sentences and words. Even though a modified version of Saltz and Dixon's procedure was used, it was expected that the results would support the view that motoric imagery through motor enactment of words can facilitate memory for children. This would suggest, as Saltz and Dixon implied, that training for motor enactment can produce relative improvement in cognitive development.

The results from Experiment 1 indicated no significant difference between the active and non-active groups. Although the means and standard deviations of the active group were greater than those of the non-active group, the *t* test indicated this was a trend rather than a significant difference.

The most obvious variable to consider is the population size. The total population in the study was 39. This is much smaller than Saltz and Dixon's sample size of 128 subjects. Perhaps an increase in the number of subjects

would have enabled the statistical model to identify any relationships more clearly.

The sentences that were used in Experiment 1 were the same set that Saltz and Dixon used in their study. It is important to recognize the possibility that the nature of the sentences affected the test results. No attempt was made to control for subject's familiarity with the words or the meaning of each sentence. Although all of the students understood English for example, a few of them may have had less understanding than others as English was their second language. Similarly, some authors (e.g., Best,1983) might argue that Saltz and Dixon's materials had a pro-male bias. The choice of sentences therefore, may have influenced the results.

Saltz and Dixon noted in their study that they did not attempt to find a random sample of all possible sentences. However, they did perform an item analysis over each of the twelve sentences to determine if the results represented the effects of only a small subset of the sentences. The item analysis showed that the same pattern of results was apparent in all twelve sentences.

Another variable that was considered to be a critical factor was the time on task for the experimental group in comparison to that of the control group. Prior to the study, a pilot test was conducted to determine any difference in task time between the active and non-active groups. The non-active subjects were told to repeat each sentence twice before proceeding to the next sentence. The pilot test indicated that this action controlled for any additional rehearsal time spent on task that occurred as a result of motor enactment.

Past educational experience of the subjects in Experiment 1 was considered when planning the study but controls were not implemented. It is possible that this factor should have been given more attention. Some subjects came from Kindergarten programs outside the school, another group had three years of

Montessori training and the third group had previously attended the school's Senior Kindergarten program. It is possible that one group entered into the study more prepared than the others as a result of their previous educational experience.

The role of the tester in Experiment 1 should be considered in this discussion. It is possible that there was an unintentional bias towards individual students when administering the "memory-for-sentences" test since the tester was familiar with most of the students already. It is also possible that the administration of the test changed as the tester gained experience. This would imply that test scores of subjects who were tested first were less reliable than the test scores of subjects who were tested later.

Environment may have had some effect on the results. The room that was used during Experiment 1 was the principal's office, located directly across the hallway from the Grade One students' classrooms. It was assumed that there would be familiarity with this location because the door was open most of the time and the students could easily see inside from their coat area and classroom. Each student's testing session took place in this office with the tester. There may have been environmental factors within the office such as chair comfort and visual distractions that affected subjects' attention and subsequent performance.

At this point in the discussion of Experiment 1, it is appropriate to discuss two aspects of the method used in the Saltz and Dixon study. Initial interpretation of Saltz and Dixon's method description led to the method used in this study; that is, the subjects learned the twelve sentences, then the memory test was administered. In actual fact, the description given by Saltz and Dixon does not state clearly whether all twelve sentences were presented as a set or whether there were two sets of six sentences each. If the latter method was used by

Saltz and Dixon, then this would indicate clearly that Experiment 1 had an error in method. Perhaps, a repeat of the experiment using the latter method may produce results that support the findings of Saltz and Dixon.

The second aspect of Saltz and Dixon's study that is relevant to this discussion is the number of experimental conditions that were present in the study. They were interested in the performance of adults as well as children, whereas the focus of Experiment 1 was with children only. Saltz and Dixon also had four conditions because they were trying to determine if enactment was more effective at the information input stage or at the information output stage. Their groups were as follows:

(1) input - no act, output - no act

(2) input - act, output - act

(3) input - act, output - no act

(4) input - no act, output - act

In Experiment 1 of the present study, it was decided deliberately to focus on only two of Saltz and Dixon's subject conditions with children; 1 and 2 as described above.

Although the results in Experiment 1 were not statistically significant, it can be seen from the preceding discussion that there are several aspects of the study's design that can be revised. It would be appropriate to make the suggested revisions and then, repeat the study again.

Experiment 2

The focus of this experiment was to use the information from the replication of Saltz and Dixon's study (Experiment 1) to develop a physical education program that would enhance some of the skills that the children were taught in their reading program. In their study, Saltz and Dixon suggested that motoric

imagery should facilitate memory for sentences. Experiment 2 intended to apply this theory to Grade One students' ability to remember words from their reading program. This was done through integration of the students' Grade One reading program with their physical education program.

Many of the critical points discussed in relation to Experiment 1 also apply to Experiment 2. These points can be described in relation to Experiment 2 along with other factors that may have affected the results of the experiment.

The experimental period was only eight weeks long. During this time, the subjects had physical education three times weekly, thirty minutes each time. The reading classes occurred every day for forty minutes. Perhaps any effects due to the physical education program are small and would only be evident after a longer period of time. It is possible that a lengthier experimental period would produce results that detected differences between the experimental and control groups more clearly. Similarly, having a larger sample would increase the power of the statistical design and might lead to different results.

Another factor to consider would be the specific months that were chosen as the experimental period. This is particularly significant with Grade One students since it is common to have only a few who can read at the beginning of the school year. Most of the students will have improved considerably by April. The experimental period for Experiment 1 began in November and ended in January, due to breaks for school holidays. Perhaps the study period should have begun in mid-September and ended in mid-November, thus avoiding the longer holiday break in December.

Although an attempt was made to control for differences in teacher and tester style, both of these variables must be considered when discussing the results of the study. Random assignment was used to place students in the control or experimental group. It was felt that this method addressed the issue of possible

differences in teaching styles of the two classroom teachers who were responsible for the reading program. However, teacher differences may have had a greater effect than the experimental manipulation.

Similar to Experiment 1, the environment may have affected students' performance on the WRM--R. Once again, the principal's office was used for testing purposes. Chair comfort, visual distractions and occasional hallway noises (students leaving for recess) may have affected the subject's ability to attend to the test. During the post-test period, there were occasions when the tester complained about cold temperatures in the office. Since there were no other rooms available for testing, it was necessary to cope with the problem. Although none of the students complained about discomfort as a result of room temperature, it should be considered as a factor that may have affected the results.

The pre-test phase of the WRM--R was administered by the principal investigator and the post-test administered by another individual who was "blind" to the purpose of the study. Although efforts were made to achieve consistency in the administration of the test, it is likely that differences in the style of the two testers had an affect on the resulting test scores. The students were quite familiar with the initial tester since she was their gym teacher. The post-test administrator was unfamiliar with the students, thus decreasing the comfort zone and possibly increasing apprehension with the subjects. This factor may have affected the students' performance.

The WRM--R test appeared to be the most appropriate test to use in this experiment considering the subjects' ages and level of reading ability. Nonetheless, it is possible that the test was not sensitive enough to the changes that are occurring with readers at this level.

The results of the WRM--R test did not support the hypothesis that active

learning in a Grade One reading and gym program enhances the students' reading skills. It is possible though, to make note of other relationships within the test scores that may be pertinent to the discussion.

With the exception of one test, the experimental group scored higher than the control group during the pre-test phase. It is interesting to note that this relationship did not occur in the letter identification test: the female control group's mean test score of 107 during the pre-test phase was much higher than the other groups' scores. Moreover, the female control group's mean test score of 106.7 during the post-test phase indicated little change in the group's performance. Improvement over time was more apparent with the other groups' performance on the letter-identification test because the pre-test scores were lower. While the female control group was able to maintain the performance score over time, the other three groups were able to improve performance such that their post-test scores were similar to that of the female control group.

The mean scores for the Visual-Auditory Learning test show the greatest improvement over time, with the experimental males making the most substantial gains. Interestingly enough, the experimental females showed the least improvement of the four groups. The reasons for this occurrence are not clear. It can only be assumed that underlying factors (e.g., ability, hearing, etc.) contributed to this difference between subjects.

Recommendations

As was discussed in the second chapter, there is ample literature available that supports the theory that physical activity can enhance academic skills with children. The purpose of this study was to investigate this theory further through replication of a study that determined a positive relationship between motor enactment activities and memory. The theory was then applied in an

experimental program with the intention of providing significant results that supported the theory.

Although the results of both experiments showed no significant relationship between physical activity and academic skills, it is possible that the error in the experimental design was a major factor in determination of the results. As was discussed earlier, there are several areas that can be changed.

Saltz and Dixon's levels-of-processing theory and memory for sentences technique were the focus of Experiment 1. Although the results did not support Saltz and Dixon's findings, it is recommended that further investigation continue in this area. It would be useful to replicate the experiment with a larger population size; in fact, 64 subjects would be suitable as it is the same number of child subjects chosen by Saltz and Dixon.

Although the choice of sentences was identified as a possible weakness in the experimental design, it is an integral part of the study done by Saltz and Dixon. The sentences are a definite part of the memory-for-sentences technique and therefore, should remain as is if another replication is planned.

In the original experiment, Saltz and Dixon were not clear in their description of the presentation method used when introducing the child subjects to the sentences. Experiment 1 assumed that Saltz and Dixon presented all twelve sentences before recall was requested and thus, replicated this procedure. It is recommended that further replication include a presentation method in which the twelve sentences are divided into two subsets of six each, with recall requested after each set.

It was beyond the scope of the present study to consider the effect of enactment at input versus its effect at output; instead, the focus was enactment versus no enactment. Future studies in this area should give consideration to this and include a subject population size that is large enough to divide into the

following four study groups:

(a) enactment at input and enactment at output;

(b) no enactment at input and no enactment at output;

(c) no enactment at input and enactment at output; and

(d) enactment at input and no enactment at output.

The discussion will now consider recommendations related to Experiment 2. Although it was not apparent in the statistical results, the eight-week program was beneficial to both staff and students involved in the study. The gym teacher and the reading teacher developed a working relationship that was closer and ultimately, led to revisions in the existing gym program. As a result of this, it is recommended that regular planning continue between the classroom teacher and the gym teacher to build activities that are complimentary. It is also recommended that recognition be given to the value of games and activities that practise academic skills, along with physical skills.

The experimental design of Experiment 2 can be improved by increasing the population size. Similar to Experiment 1, a larger group of subjects would allow more effective use of the statistical model.

The experimental period consisted of three gym classes each week for a period of eight weeks. Any replication of the study should consider increasing the experimental period either by having daily gym sessions for eight weeks or by lengthening the experimental period to twelve weeks, with gym sessions three times each week. This could involve careful scheduling since every effort should be made to avoid the longer school holidays such as Christmas break and March break. Ideally, an appropriate testing period would be early September with the experimental period lasting from mid-September to late November. This would allow post-testing to take place in December.

The standardized tests that identify reading skill level with young children

should be reviewed carefully before considering replication of the testing procedure that was used in Experiment 2. Although the WRM--R was originally believed to be the most appropriate test, results of the study suggest that the test may lack sensitivity to the changes that occur in early readers.

Conclusions

It was the intent of this investigator to present a study with results that would support the view that physical action, specifically motor-encoding activities, will enhance the academic ability of students, particularly primary grade students. Although the data did not support the hypothesis and there were possible errors in the experimental design, one can learn a great deal from the process of organizing the study. Considering this, the study was a worthwhile experience. Another replication, with the suggested changes in design, could lead to results that are quite different.

The role of active learning in education, particularly with young children, has been well documented by past researchers. There are areas of the curriculum, such as music education, where active learning is more natural. However, there are also areas of the curriculum where traditional teaching methods are too limited and place too much emphasis on visual and auditory learning modes. The ways in which children learn are so diverse that it is necessary for teachers to provide an environment and activities that satisfy all learning styles.

Hopefully, further research into the relationship between active learning and cognitive development will provide information that will prove to be useful for those who design and implement curriculum.

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APPENDIX A : LETTER OF EXPLANATION AND CONSENT FORM

September 27, 1988.

Dear Parents of Primary Six Students:

As you may know already, I have taken a sabbatical leave from my teaching position at the College and intend to use this time to complete the thesis portion of the Master of Education program through Brock University.

My general topic is the use of physical activity to enhance academic skills. More specifically, I hope to compare the effectiveness of a gym program that deliberately complements the grade one reading program relative to the existing program.

The study involves three components that are described below;

I Pre-Test Phase: The children will be asked to complete a reading test and a memory test that involves remembering simple sentences. I will administer these tests individually.

II Program Phase: The second phase of the study will last for five weeks and will involve the reading and gym programs. The children will be randomly assigned to one of the following two groups:

> Group A: These children will participate in the school's existing reading and gym programs.
>
> Group B: These children will complete the school's existing reading program, but their gym program wil be designed to deliberately complement the reading program.

III Post-Test Phase: The children will be asked to complete the same reading and memory tests that were administered as a pre-test.

The study's results will be used to make recommendations towards the revision of the Early Education physical education program at Hillfield-Strathallan College.

As I would like to involve students in the Primary grade one program in this study, I am approaching you to ask if you will permit your child to be a

participant in the study.

Test scores and all other data regarding your child will remain confidential. Students will remain anonymous in the completed report; moreover, you are free to withdraw consent at any time.

You are welcome at any time throughout the study to speak with me regarding any questions that you may have.

Sincerely,

Carol Stanton
Early Education Department

I / We, _____, give permission for our child, _____ to participate in the Primary grade one "Reading - Gym program" study. I / We understand that subjects of the study will remain anonymous and that I / we may request information about our child's performance in the study, if I / we wish. I / We understand that my / our child will be asked to complete reading and sentence memory tests on two occasions as well as participating in a reading and gym program. Finally, I / we understand that I / we may withdraw consent at any time.

_____
Signature of Parent or Guardian

APPENDIX B: SAMPLE OF SCORE SHEET - EXPERIMENT 1

SENTENCE #	SUBJECT	OBJECT
1	workman	hole
2	doctor	chair
3	mother	paper
4	squirrel	acorns
5	soldiers	battle
6	man	wood
7	horse	fence
8	teacher	finger
9	fireman	building
10	boy	stone
11	baby	dog
12	airplane	clouds

TOTAL SCORE:

APPENDIX C: DESCRIPTION OF PILOT TEST FOR EXPERIMENT 1

The purpose of the pilot test was to determine the time on task for both the experimental and control groups and to ensure that one group would not have the advantage of additional time on task. The pilot test occurred during the Spring term that preceded the Fall experimental period. Twenty-four grade one students were asked to participate; twelve in the control group and twelve in the experimental group. Four of the sentences from Saltz and Dixon's experiment were used:

The WORKMAN was digging a HOLE in the ground.

The HORSE jumped over the FENCE.

The BOY threw a STONE into the water.

The CHEF flipped the PANCAKE.

Each of the students was told that he / she would be taking part in a "memory game" for children. During the pre-test phase, each of the control group subjects heard the sentence when the tester said it and then, repeated the sentence twice. The experimental group heard the sentence, repeated the sentence once and acted out the sentence's meaning. After all sentences were read, the subjects were told to count to 30 during the interval between learning and recall of the sentences. The post-test involved hearing the verb of the sentence as a cue before attempting to recall the sentence. The experimental group was encouraged to enact the verb's meaning before attempting to recall the relevant sentence. The tester kept an accurate record of the times for each testing session.

Results of the pilot study indicated no significant difference in the time on task.

APPENDIX D: F TABLES FOR EXPERIMENT 2

Summary of ANOVA Results for Word Identification Subtest

Source	DF	F	P
BETWEEN SUBJECTS EFFECTS			
Group	1	.59	.45
Sex	1	.001	.98
Group X Sex	1	.25	.62
Error	34		
WITHIN SUBJECTS EFFECTS			
Time	1	10.41	.003
Group X Time	1	.54	.47
Sex X Time	1	.26	.61
Group X Sex X Time	1	1.16	.29
Error	34		

Summary of ANOVA Results for Letter Identification Test

Source	DF	F	P
BETWEEN SUBJECTS EFFECTS			
Group	1	.44	.51
Sex	1	2.83	.10
Group X Sex	1	1.97	.17
Error	34		
WITHIN SUBJECTS EFFECTS			
Time	1	10.15	.00
Group X Time	1	2.41	.13
Sex X Time	1	.58	.45
Group X Sex X Time	1	1.49	.23
Error	34		

Summary of ANOVA Results for Visual-Auditory Learning

Source	DF	F	P
BETWEEN SUBJECTS EFFECTS			
Group	1	1.64	.21
Sex	1	.30	.58
Group X Sex	1	4.06	.05
Error	34		
WITHIN SUBJECTS EFFECTS			
Time	1	66.14	.00
Group X Time	1	.67	.42
Sex X Time	1	1.12	.30
Group X Sex X Time	1	4.36	.04
Error	34		

Summary of ANOVA Results for Passage Comprehension Subtest

Source	DF	F	P
BETWEEN SUBJECTS EFFECTS			
Group	1	.10	.75
Sex	1	.09	.77
Group X Sex	1	.01	.94
Error	34		
WITHIN SUBJECTS EFFECTS			
Time	1	49.34	.00
Group X Time	1	.71	.41
Sex X Time	1	.11	.74
Group X Sex X Time	1	.03	.87
Error	34		

Summary of ANOVA for Word Attack Subtest

Source	DF	F	P
BETWEEN SUBJECTS EFFECTS			
Group	1	.29	.59
Sex	1	.08	.77
Group X Sex	1	.009	.92
Error	34		
WITHIN SUBJECTS EFFECTS			
Time	1	13.20	.001
Group X Time	1	.47	.50
Sex X Time	1	2.08	.16
Group X Sex X Time	1	.00	.95
Error	34		